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PG&E Letter DCL-08-089

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Licensee Event Report 2-2008-001-00
Reactor Trip Due to Main Electrical Transformer Failure

Dear Commissioners and Staff:

In accordance with 10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(iv)(A), Pacific Gas and Electric Company is submitting the enclosed Licensee Event Report regarding a reactor trip due to the failure of a high voltage bushing associated with the "C" phase main electrical transformer.

There are no new or revised regulatory commitments in this report.

This event did not adversely affect the health and safety of the public.

Sincerely,

James R. Becker

ddm/2246/A0738079
Enclosure
cc/enc: Elmo E. Collins, NRC Region IV
Michael S. Peck, NRC Senior Resident Inspector
Alan B. Wang, NRR Project Manager
INPO
Diablo Distribution

JE22
NRR

NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 06/30/2007

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Diablo Canyon Unit 2	05000323	1 OF 6

4. TITLE

Reactor Trip Due to Main Electrical Transformer Failure

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
08	16	2008	2008	- 001 -	00	10	15	2008	FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE

1

10. POWER LEVEL

100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

- ☐ 20.2201(b)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☐ 50.73(a)(2)(i)(A)
- ☒ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☒ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
Steven W. Hamilton – Senior Regulatory Services Engineer	(805) 545-3449

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
X		TGMC	HSB	No					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On August 16, 2008, at 23:57 PDT, with Unit 2 in Mode 1 (Power Operation) at approximately 100 percent power, a main generator Unit Trip signal initiated a Reactor Trip due to the failure of the main electrical transformer "C" phase. On August 17, 2008, at 00:12 PDT, plant operators declared an Unusual Event (UE) due to an observed fire at the "C" phase transformer. Plant operators made an Emergency Event Notification (EN 44419) in accordance with 10 CFR 50.72(a)(1)(i) at 00:37 PDT. Plant operators stabilized Unit 2 in Mode 3 (Hot Standby) and updated the UE that the fire was out at 02:02 PDT. At 07:38 PDT, EN 44419 was updated to specify 10 CFR 50.72(b)(3)(iv)(A) and 10 CFR 50.72(b)(3)(iv)(B).

This event was due to a catastrophic failure of the main electrical transformer "C" phase high voltage bushing. The event investigation will continue, however, this event is considered a random component failure based upon onsite inspections and vendor reviews performed.

Corrective actions include the "C" phase transformer replacement, electrical tests of transformers and bushings, oil analysis of transformers and bushings, installation of a bushing monitoring system, evaluation and replacement of equipment damaged as a result of the electrical failure, and review of industry and station operating experience regarding main transformer issues.

TEXT

I. Plant Conditions

Unit 2 was in Mode 1 (power operation) at approximately 100 percent power.

II. Description of Problem

A. Background

During normal operation, the main generator's output is stepped up from 25kV to 500 kV via the main bank transformers, which consist of three separate transformers, one for each phase. The main bank transformers were placed in service during October 1999. The 4kV vital buses are powered from the auxiliary power system fed from the main electrical generator via auxiliary transformers that step the voltage down from 25kV. The 230kV system provides an immediately available source of offsite power to the 4kV system. The 230kV system provides power to Startup Transformers (SUTs) [EA][XFMR] 1-1 and 2-1 (230kV to 12kV), which feed the SUT 1-1 and 2-2 (12 kV to 4kV), respectively. SUT 1-1 and 2-2 then supply power to the 4kV vital bus and 480V vital buses.

Each Diablo Canyon Power Plant Unit has three onsite emergency diesel generators (EDGs) [EK][DG], which supply power to the 4kV vital AC buses [EA][BU] whenever power is either unavailable, or voltage degrades below the point at which required loads could become inoperable. EDGs automatically start on a safety injection signal, degraded or loss of voltage on the associated vital bus, or undervoltage on the 230kV startup power system. This event did not result in the starting or loading of the EDGs.

The protection of the transmission system and main electrical generator (including isophase bus and connected transformers) are provided by relays, which sense line faults, and initiate signals to their respective breakers to open the breaker and isolate the fault. The main electrical generator output transformer is protected by phase differential relays that sense the difference between phases to provide equipment protection during normal operation.

Technical Specification (TS) 3.8.1, "AC Sources – Operating," Action A.1, requires verification of the operability of the independent circuits between the off-site transmission network and the on-site distribution system when in the action statement. Surveillance Test Procedure (STP) I-C, "Routine Weekly Checks Required by Licenses," Attachment 12.4, verifies, that "At least one 230kV line is energized and its respective ...{breaker} is

operable...," via the SUT. The conditional surveillance is required to be performed within, "1 hour and once per 8 hours thereafter."

B. Event Description

On August 16, 2008, at approximately 23:57 PDT a main electrical output transformer "C" phase oil filled high voltage output bushing experienced a high energy phase to ground electrical fault resulting in catastrophic failure. An automatic main generator Unit Trip signal resulted in an automatic Reactor Protection System (RPS) Reactor Trip initiate signal.

On August 17, 2008, at 00:12 PDT, licensed plant operators declared an Unusual Event (UE) due to an observed fire at the main electrical transformer "C" phase that was not extinguished within 15 minutes.

On August 17, 2008, at 00:24 PDT plant operators initiated a required conditional surveillance in accordance with TS 3.8.1, Condition A.1, to be performed within 1 hour by completing STP I-1C, Attachment 12.4.

On August 17, 2008, at 00:37 PDT plant operators made an emergency event notification (EN 44419) in accordance with 10 CFR 50.72(a)(1)(i) for the fire. They also described the resultant automatic Reactor Trip and auxiliary feedwater actuation.

On August 17, 2008, at 02:02 PDT plant operators stabilized Unit 2 in Mode 3 (Hot Standby), and updated EN 44419 to include termination of the UE.

On August 17, 2008, at 03:27 PDT plant operators logged STP I-1C, Attachment 12.4, completing TS 3.8.1, Condition A.1, as a late conditional surveillance.

On August 17, 2008, at 07:38 PDT, plant operators updated EN 44419 to specify the system actuations in accordance with 10 CFR 50.72(b)(3)(iv)(A) and 10 CFR 50.72(b)(3)(iv)(B).

C. Status of Inoperable Structures, Systems, or Components that Contributed to the Event

None.

D. Other Systems or Secondary Functions Affected

No Unit 2 safety systems were adversely affected by this event.

Unit 1 was unaffected and remained in Mode 1 at approximately 100 percent power.

E. Method of Discovery

The event was self-revealing to licensed control room operators by annunciators indicating the Unit Trip and RPS Reactor Trip condition, and the automatic actuation of both motor-driven auxiliary feedwater pumps.

F. Operator Actions

Licensed plant operators declared an UE due to an observed fire at the "C" phase transformer and made an EN by phone via the emergency notification system (ENS). Plant operators stabilized Unit 2 in Mode 3, verified that the fire was out, and terminated the UE. Plant operators updated ENS notification EN 44419 to specify the 10 CFR 50.72(b)(3)(iv)(A) and 10 CFR 50.72(b)(3)(iv)(B) events.

G. Safety System Responses

The Unit 2 main electrical transmission relay protection scheme automatically initiated a main electrical generator Unit Trip and RPS Reactor Trip. The Unit Trip initiated a transfer to the preferred source of power (230kV startup power) as designed. The RPS Reactor Trip signal removed the gripper power from the reactor control rod drive system, and allowed the rods to drop into the core shutting down the reactor as designed. Two motor-driven auxiliary feedwater pumps automatically started to provide cooling water to the four steam generators to cool the reactor coolant system as designed.

III. Cause of the Problem

A. Immediate Cause

The Unit 2 main electrical transformer "C" phase high voltage bushing experienced a phase to ground high energy electrical fault resulting in catastrophic failure of the bushing. The main electrical transformer protection relays initiated a main generator Unit Trip and RPS Reactor Trip signal.

B. Root Cause

The presumptive root cause for the failure is either an internal degraded test tap connection, or low bushing oil level in the "C" phase high voltage bushing. The failure rate of oil-filled high voltage transformer bushings is well within the assumed random single failure rate previously analyzed.

The root cause team identified that a degraded ground on the "C" phase high voltage bushing test tap may have resulted in a partial discharge condition. Due to the catastrophic failure of the bushing, arcing within the test tap and the total destruction of the test tap connection at the condenser foil, the root cause team was unable to determine if the test tap ground was degraded, or if there was a loss of oil that initiated the failure.

IV. Assessment of Safety Consequences

There were no safety consequences as a result of this event. Unit 2 automatically initiated a main electrical generator Unit Trip and RPS Reactor Trip. The Unit Trip initiated an automatic transfer to the preferred source of power (230kV startup power) as designed. The RPS Reactor Trip signal allowed the reactor control rods to drop into the core shutting down the reactor as designed. Two motor driven auxiliary feedwater pumps started, and provided cooling water to the four steam generators cooling the reactor coolant system as designed. The loss of main generator electrical output is a Condition II event previously analyzed in the Final Safety Analysis Report Update, Chapter 15.2, "Condition II – Faults of Moderate Frequency."

In the unlikely event that the preferred offsite source of power (230kV startup power) were unavailable or fail, the onsite EDGs were available to provide the power to the vital buses. While the transformer failure resulted in some collateral damage to nearby equipment, no personnel or safety-related structure, system, or component was significantly damaged during this event.

Unit 1 remained at full power with vital buses powered from its auxiliary transformer.

Therefore, the event is not considered risk significant, and it did not adversely affect the health and safety of the public.

TEXT

V. Corrective Actions

A. Immediate Corrective Actions

1. Pacific Gas and Electric Company (PG&E) replaced the failed main electrical transformer "C" phase with the spare from Unit 1.

2. PG&E inspected all equipment in the vicinity of the failed transformer bushing and fire for collateral damage.

3. PG&E repaired or replaced the significantly adversely affected equipment identified as a result of the transformer failure.

B. Corrective Actions to Prevent Recurrence

PG&E will improve high voltage bushing performance monitoring by:

1. Installing on-line bushing monitoring system on the Main Bank Transformer 500kV bushings for each unit.

2. Establishing daily operator rounds to verify that no abnormal condition exits at the bushing condition monitors.

VI. Additional Information

A. Failed Components

The HSP Hochspannungsgeräte GmbH (formerly ELIN) 25kV to 500kV transformer output high voltage oil filled bushing.

Model TEQ-405A44D9K99 was placed in service during October 1999.

B. Previous Similar Events

LER 1-2007-001, "Emergency Diesel Generator Auto-Start on Loss of Offsite 230kV Startup Power Due to an Insulator Failure and Unanticipated Relay Response at Substations," reported the loss of the offsite 230kV startup power due to a main transmission system insulator failure on May 12, 2007. The corrective actions taken for this event would not have precluded the current event as the corrective actions taken were for the offsite 230kV system. Additionally, this condition focused on the failure of an insulator of a significantly different design than the main transformer output bushing.